Dissertation Title:

Miracle: A VR musical exploration game with controllers in immersive physical environment

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I. Abstract

This study illustrates the considerations of developing an exploration-based virtual reality (VR) game from scratch. The central design concept was born out of a collection of Serendipities in life and a desire to bring moments that were never noticed by the player back to life in a VR environment. Furthermore, the design methodology of iterative prototyping, usability testing, and user feedback analysis was utilised in the subsequent design process. The study evaluates exploratory music games in terms of interaction ease and game task engagement based on feedback from playtesting and analyses design strategies for exploratory music games. The article summarised the findings and suggestions are made for their future development.

II. Introduction

Miracle is a practical exploration of the idea, which empowers people to explore the different moments in the dream in a virtual environment. People can change the virtual world's atmosphere, visual effects, and sounds through interaction with game objects, thus gaining peace and pleasure. This research paper describes Miracle's iterative design process and the evaluation and optimization of the game experience through VR playtesting. In addition, the study aims to summarize ways to balance the interaction difficulty and playability of exploration-based music VR games and to increase the engagement of such games.

III. Related Research

Music and play are two activities that provide a state of "mindfulness" that allows people to feel engaged and focused. Zhang and Fu's study demonstrated that background music could increase the immersion of game participants. At the same time, head-mounted displays with more substantial visual impact can also bring more immersion to players, and the clever combination of game elements and background music can unlock the immersion experience of reaching the mindstream (Xiaoqing Fu, 2015).

In VR games, interaction also dramatically affects the user's experience. As a result, more data scientists and artists are creating immersible physical experiences by using VR technology, and they are exploring innovations in the direction of interactive gesture input, multimodal input, and VR controllers. Park et al. focus on visual feedback of gesture input, and they develop gesture input for attacking enemies in user VR game content and propose several visual representation models, thus guaranteeing the user's game immersion experience (Park et al., 2021).

In contrast, Zimmerer, Fischbach and Latoschik tend to build multimodal interactions for VR games. They explored multimodal input integration based on the development of Space Tentacles, a multimodal VR adventure game, and successfully implemented a game experience that allows players to interact with each other through voice and gestures (Zimmerer, Fischbach and Latoschik, 2021). In addition to this, the artist Chen Ji proposes an innovation in VR controllers by exploring a new way to create an immersive and entertaining music playing experience by using virtual reality technology, physical instrument interfaces and exploring game concepts to provide players with a music creation experience in an immersive environment (Ji, 2021). Chen Ji applies a suitable VR controller to design a smooth user experience. However, the game still has some learning costs for non-keyboard players.

Therefore, this design project hopes to provide an immersive music creation experience for all players, exploring the design of music creation in an immersive environment with gesture input. The exploration games, often without specific, quantifiable challenges, enable players to experience environmental changes fully. The game's challenges (physical, cognitive and emotional challenges) can increase the player's immersion, and emotional challenges enable players to face narrative logic with emotional characteristics. So far, the emotional challenges in VR games have received little attention and have not been applied to VR music exploration class games. (Peng et al., 2021) However, there has been no discussion of the methodology for exploring music-based VR games, which use VR controllers as interaction hardware, the ease of interaction and playability in an immersive environment, and the enhancement of player engagement.

IV. Research Method

The study consists of two parts. The first part deals with the fundamentals of designing Miracle VR immersive games. The second part deals with game testing and adapting Miracle based on user testing results. An iterative design approach that starts with a design concept and conducts user testing is constructive for sustainable game development. By interviewing Miracle players and evaluating Miracle's design from the perspective of the experiencers, this study can provide guiding suggestions for optimizing the VR experience and comparing the perceived ease of interaction and playability of the actual immersion experience for each type of user. The dynamic, iterative design process includes continuous adjustments to the game based on playtesting results. Six testers were selected for the actual game experience and post-game user interviews and questionnaire research for the game test. The questionnaire results were quantitatively analyzed to evaluate the VR experience and the overall game dimensions, including but not limited to the actual assessment of functional interaction difficulty, playability and engagement.

V. Iterative Design Process

V.I Game Ambiance

The concept of Miracle is rooted in collecting life's serendipities. The author hopes to develop a peaceful, non-competitive music game that allows participants to escape from the real world for a brief period and perceive the beauty of overlooked scenes. It is also intended to provide an easy learning and experimentation experience for those unfamiliar with music creation. Miracle, therefore, defines a new form of music VR game, an exploration-based music game, providing players with the experience of creating music in an immersive environment, attempting to combine VR controllers to produce a design exploration of music creation in an immersive environment.
At the same time, Miracle is an exploration game, for creating the game style and scene atmosphere construction is critical.The concept of “ambiance” has been shaped over the years by questioning the interactions between three attractors: architecture and the city, climatic and sound phenomena, uses and perception (Lescop & Kepczynska-Walczak, 2019). The game atmosphere was designed regarding some of the design logic of the physical environment, including scale, spatial perception and environmental background sounds.

Figure 1: Graphic Design of Miracle

There are four main scenes in the game, with the concepts of MAGIC, PASSION, PEACE and CHILDHOOD, respectively, hoping to create a stylized scene with low-poly aesthetics. Players first entered the environment from the MAGIC scene. The MAGIC scene set up a blue ice terrain environment, containing the fundamental elements of castles, windmills, tiny houses and underwater plants. This scene mainly awakens people's internal memories about magic, where there are still magical creatures in the ice and snow. People can see fireworks and shooting stars due to interaction in that scene.

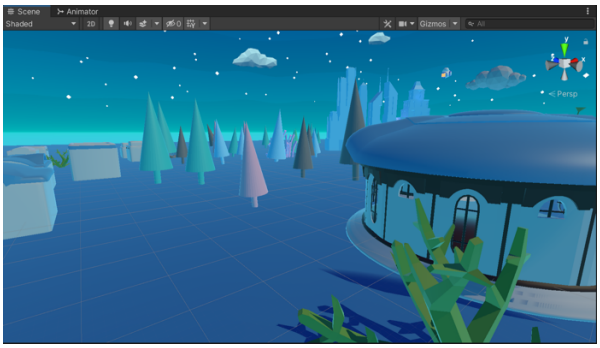

Figure 2: The MAGIC scene of Miracle

The second scene with the theme of passion is mainly based on the orange desert terrain environment, containing elements of desert plants, falling leaves, underwater creatures, and giraffes. The PASSION scene, mainly through the desert and the sun's baking, evokes people's memories of the scorching heat of summer.

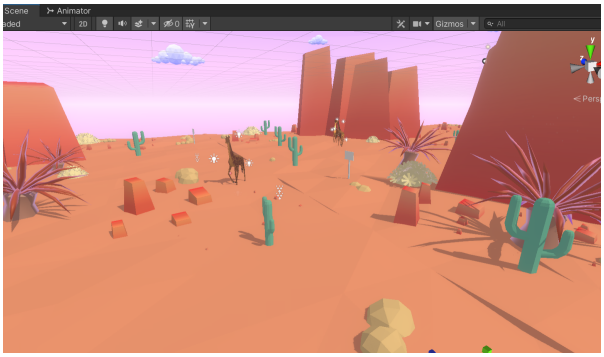

Figure 3: The PASSION scene of Miracle

The third scene is themed on peace, which is inspired by Chinese Zen culture and Japanese WABISABI culture, in which mountains, temples, lanterns on the water and clouds and deer in the mountains, all hoping to give the experience a brief moment of peace and tranquillity in this environment.

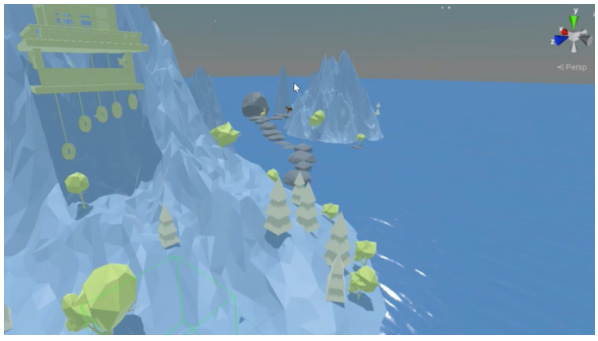

Figure 4: The PEACE scene of Miracle

The fourth scene is themed on childhood, inspired by the childhood playground, which contains balloons, Ferris wheels, colourful block-shaped figures and trees, and childhood paper aeroplanes, evoking happy memories of childhood through a series of symbolic childhood elements.

Figure 5: The CHILDHOOD scene of MIracle

Overall, players can interact with the world's natural elements to change the environment and atmosphere. Players can experience different sound and visual changes in each scene exploring the world. Each scene is set with stylized elements and focuses on the player's interaction with musical rhymes, an extraordinary attempt to musicalize the exploration game. Miracle is based on the game's desire to provide children and people new to music with something different from the immersive experience of a quest-based music game. The game's narrative mainly emphasizes making people treasure and discover the small beautiful things in life.

V.II Elements and Intelligibility

The game elements form the basis of the game and are an essential part of creating the game's atmosphere. Formal elements can define part of the game's style, but dramatic elements can convey the game logic to the player. The game rules are not meant to constrain the player but can be a tool to provide a better gaming experience. Therefore, the elements and mechanics within the game should serve the overall emotion and logic of the game. Miracle is an exploratory single player music game that provides a series of interactions that allow the player to explore the game's environment. Through the interactions, players can influence the game's environment (e.g., changing the colour of the sky and the behaviour of creatures). The rules for interaction are kept simple, requiring only two types of gestures, grabbing and teleporting, allowing the interaction space to remain more intuitive to use for players exposed to VR.

Lescop and Kepczynska-Walczak state the intelligibility of the space is derived from the awareness of ambience in which the information is perceptible but undefined (Lescop & Kepczynska-Walczak, 2019）. The game objects in Miracle are mainly in a low-poly style. Each scene will have a more evident conceptual key (e.g.,

PASSION) while aided by small non-daily interactive objects so that users can perceive the not-everyday experience in everyday scenes and bring them an incredible feeling. Players can understand the game's content from the big scene to the elements within the scene. The constituent objects such as music are also a prerequisite for players to participate in the environment. Therefore, when testers enter the game scene, they will first use 1 to 2 minutes to observe the environment and lay the foundation for their following action. Besides, the guidance text within the game is also key to enabling the user to understand the game action quickly. At each particular positioning point, players are instructed with specific floating text. Almost all game testers followed the textual instructions when they saw the guidance text. Although in the initial version of the test, the text location points had some errors and were affected by the walking order of the different testers, the testers had an evident perception of the overall style of the environment and showed enthusiasm for exploration. Thus, although the exploration process varied from person to person, each tester was able to have a deep impression of the triggered interactions and the environment and hope to have more influence on the environment.

V.III Interactions

Both motion and interaction in VR games are challenging. Despite developers' attempts at multiple motion solutions, the technology is often accompanied by problems such as discomfort, which may result from the visual and vestibular systems receiving conflicting information stimuli.

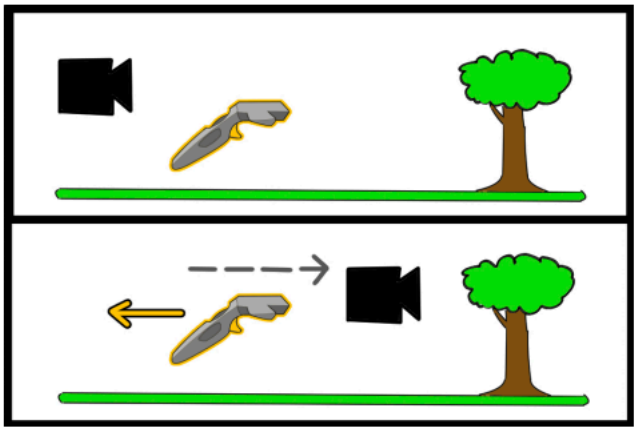

Figure 6: Point–Tugging: Users grab a point in 3D space and pull the VE towards (or away from them). In this diagram, the camera indicates the view of the participant with the user pulling the controller backward to move forward in the VE.

Both motion and interaction in VR games are challenging. Despite developers' attempts at multiple motion solutions, the technology is often accompanied by problems such as discomfort, which may result from the visual and vestibular systems receiving conflicting information stimuli.

The Point-Tugging interaction is chosen. The users can grab a point in 3D space and pull the VE towards (or away from them). In this diagram, the camera indicates the participant's view, with the user pulling the controller backwards to move forward in the VE. The point-tugging way can provide people with more familiar game mechanics and ensure that players do not lose interest when they start the game. According to Miracle's test results, 60% of testers began to experience motion sickness in the third scenario (totally about 10 minutes within the game at this point).

Game elements have two main functions, the first is to inform the player of the nature of the current game scene, and the second is to present the player with the possible interaction or functional design of the scene. Based on observations of gamer behaviour during the playtest, three of the six testers took some time to become aware of the interactive features of the game objects involved. They were generally players who lacked VR game experience and needed some guidance during the building blocks of Scene 4 to understand the specific interactive operations. However, when the players understood the principle of Miracle, they were very immersed in the interaction with the game objects. In the game, the starfish in Scene 1 was not interactive, and only some of the giraffes in Scene 2 were interactive, but all four players tried to interact with them. Because both of them present the characteristics of prominent colour and dynamic effect in the scenes, players will be aware that such objects are interactive.

On the one hand, the game environment and the various stylized elements that make up the environment can immerse the players in the specific scene under that stylization. They can attract players and make them interested in each object within that scene. On the other hand, whether the game objects within the scene can be interacted with and in what form the player should interact with them needs to be more clearly presented. The interaction within the game should be highly recognizable and achievable. If players cannot discover how to interact with an interactive object in a limited time, they will receive frustration-like feedback and lose interest in the game. In this game, if the interaction time is too long, there is a risk that the player will become motion sickness. In the initial version of Scene 1, for example, the player can control the height of the cloud to obtain different environmental changes and sound effects. However, no guidance text has been added at this time, and the player cannot quickly obtain how to interact with the non-daily game object "cloud" until the first two playtesters do not finish interacting with the clouds.

In addition, the interactions were subdivided into three types, semi-automatic guided particles, environmental creatures, and non-daily primary interaction "interfaces". To maximize the game experience and present the differences between the different game objects to avoid getting lost in the game scenario. In contrast, all the interactive objects Miracle's principles for shaping environmental creatures follow the rules of the natural world, such as when people interact with deer and giraffes, the creatures will avoid humans just like deer and giraffes in real life. For non-daily game objects, interactions with similarity can effectively strengthen players' interaction habits. In

scenes, one, two and three, the musical interaction objects (clouds, rocks, and the pull ring of the clock) all follow the interaction form of pulling up and down, so players can smoothly interact with these three objects without guidance. At the same time, four testers thought that the fourth scene's musical Four testers found the fourth scene's music challenging to interact with, which was also due to the lack of consistency with the interactions in the previous scenes. However, the players accepted the differences, as they were impressed by the music interaction module in the last scene. The interaction in building blocks was consistent with the concept of childhood in that scene. Therefore, in addition to maintaining the similarity in the interaction of game objects, it is necessary to consider the compatibility with the concept of four scenes.

V.III Atmospheric and Sound Phenomena

The atmosphere of the game content is mainly accumulated by the visual and sound effects of various game elements. The change of atmosphere within the game contributes to the expression of the game narrative and enables participants to gain a more lasting attraction. In Miracle, playtesters were impressed by the beautiful impressions of the ambient atmosphere created by interactions in the space, such as fireworks, aurora borealis and shooting stars. Others expected creature interactions within the environment, believing that environmental creatures could bring interesting atmospheric additions to the scene.

To provide a way for people to combine music and game elements well, Miracle will pre-set the initial state of the four scenes, and the player's task is to change the atmosphere of the entire scene by interacting with the world. As the player changes the objects of each scene music interaction, pre-designed animations will be triggered, and some previously hidden effects will appear. Although Miracle is a musical exploration game, it does not mean that we need to set the whole game to a silent state. Players do not need to wait for the player's interaction to trigger the music, where is still background music to create the atmosphere. However, the background music instruments, beats and the original music master will be expanded or reduced during the interaction process.The players have optimal gameplay experience when they are able to choose the background music they prefer. Therefore, this game is designed to provide background music choices for the player (CASSIDY and MACDONALD, 2010).

The overall music satisfaction showed some similarities. During the interviews, most game testers perceived the changes in sound effects apparent and could immerse them quickly in the corresponding scenes. In contrast, a few testers focused on the interactions and did not perceive the changes in the game background music with the interaction controls. In addition to this, one game tester suggested that changes in the background sound could be presented through more visual changes in the scene.

V.V Game emotional transfer and interaction difficulty

VR significantly enhanced and broadened participants' emotional responses, appreciation, immersion and presence. (Peng et al., 2021). We can use this medium to convey the emotions we want to convey through the game. Miracle aims to create a calm and pleasant virtual space where players hope to perceive some calm pleasure and take a short, discreet break. Participants are immersed in four different rooms in blue, orange, off-white and warm yellow tones, with changing lighting sets and rich background sounds. Miracle provides people with emotional values in four dimensions: mystery, enthusiasm, calmness and fun, and its purpose is to encourage people to recall real-life moments through their experience of the virtual world, in addition to the spectacle of something beyond reality. Players were encouraged to participate in the construction of the world atmosphere. All playtesters enjoyed the interactive parts of the world. All gamers claimed that they could have unexpected fun exploring it and felt varying degrees of calmness from it.

At the same time, as far as exploration games are concerned, one of the main challenges faced by artists and designers is that not all elements are relevant to the plot. It seemed challenging to point players in the right direction without sacrificing the challenges necessary to keep their interest (1) Miracle's initial version did not include guide text. Hence, players needed to explore the world at the beginning to test possible interactions with each element, making it difficult for players unfamiliar with VR games to find out how to interact with the interactive objects. Miracle is guided to follow the movement of the particles after entering each scene, and players can choose to follow or explore on their own, which makes it easier for players to get lost in the scene when they are not thoroughly familiar with the environment. No one thinks the interaction is difficult to understand, which shows that exploration and familiarity with the world are key players when they start the game. If players are to experience as many of the critical interactions as possible, they need to be given ongoing stimulation throughout the game. The feedback means that the richness of the interactions needs to be increased at different guidance nodes. From the playtesters' feedback, all of them interacted with the white deer and lights on the water surface in Scene 3. Some players thought that this interaction could well shape a calm atmosphere for Scene 3. At the same time, two of the playtesters did not find the grey stones in Scene 3 and therefore did not experience this interaction. Hence, the necessity of this gameplay deserves to be considered again. Among the other scenarios, they found the process of building the woods in Scenario 4 impressive, and all of them talked about how interesting this scenario was in their impressions of the game. However, most of them found this part of the interaction difficult.

In terms of game guidance, all testers found the guidance text to be clear and could find some of the overlooked interaction objects in the scene from the guidance text. Some players wanted more invisible physical guidance to get more precise guidance for the next interaction. The playing time lasted 15-20 minutes in the version without the guide text. Some players experienced motion sickness and had to stop without triggering all interactions in the last scene because of motion sickness. At the same time, some testers also experienced exhausted patience, which was all caused by the

lack of guidance. Thus, in the second version, testers could complete small in-game tasks within 10-15 minutes, and some would experience more than 20 minutes in the game. According to interviews, the main reason for this was the limited nature of the game elements and occasional motion sickness conditions that made the game unattractive.

VI. Discussion and Future Work

The COVID-19 pandemic has a bad influence on program development. The scope of the results is limited by the small sample size of only 6 participants recruited so far in this iteration of the program due to social regulations. However, these preliminary findings enable us to consider continued iteration and optimization.

By implementing an iterative design approach in the design process, this study shows the points of difference between users' concerns in the immersive experience and designers' design expectations and the authors' adjustments and optimizations for these differences. Through user interviews with testers who have played Miracle, the authors' expectations and anticipation of users' expectations of Miracle's experience, such as the interaction style, interaction objects, and sound effects dimensions, are essential for the later iterations of Miracle. However, each player's motivation for playing the game is somewhat different and may be related to the player's own past gaming experience, gaming preferences, and physiological and psychological background. Therefore, there are often biases and variations in users' game perceptions and behaviours. Unforeseen problems and information within the game can be collected employing game testing.

VI.I Interaction difficulty balance

The authors used the information to analyze the reasons for its appearance, and the game's iteration and optimization direction had a specific reference. In the early versions of Miracle, there were problems with the user's movement speed and the problem of small collision bodies. It was a big problem, bringing weightlessness to the players and making them more prone to motion sickness, preventing them from experiencing the entire interaction in the game. Therefore, the general feedback from early beta testers of Miracle was that:

- the player moved too fast and experienced motion sickness in the third scene of the river crossing;
- the user quickly fell into the river in the third scene;
- the interaction with the first three scenes was less complex than the fourth scene.

Therefore, the form of movement in the first viewpoint requires consideration of the user's speed of movement in this form and the size of the collision body represented by users, all of which affect the game's playability.

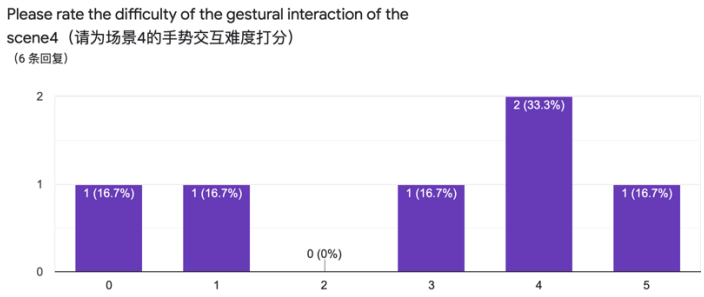

Figure 7: User research result of Miracle (1)

However, the game's playability is sometimes not affected by the great difficulty of the game. Regarding the difficulty of the fourth scene interaction compared to the other scenes, the authors decided to fine-tune the parameters but not change the interaction's form. Because almost all players consider such interaction to be exciting and in line with childhood associations, and if it were simplified, it would lose some of the game's features. Therefore, according to the test results, the authors changed the game's user movement speed and the size of the user collision body. The authors changed the parameters of the fourth scene of building the woods.

VI.II Game mission participation

The results of Miracle's playtest indicated that almost 83.3% of the players were very involved in Miracle. With the further analysis of the interview results, the authors learned that the testers were still more likely to notice the visual changes and less concerned about the musical changes in the exploratory music interactive game. However, the background music could make the players enter the game faster and convey the characteristic emotions more directly. The background music can make players enter the game faster and convey the characteristic emotions more directly. The lack of attention to music may also be due to apparent superimpositions on selecting sound sources.

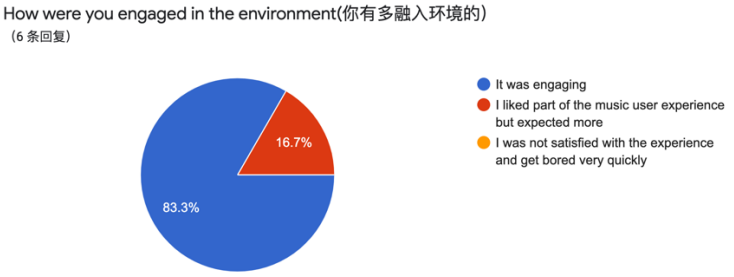

Figure 8: User research result of Miracle (2)

However, it is worth noting that the questionnaire result shows that players are more impressed with the interactable objects in the game. It indicates that the game attracts different players by enriching the interactable objects and interaction methods. In addition, players expect to move the interactable objects more freely in future versions, and some want more evident gesture interaction and more precise music control effects.

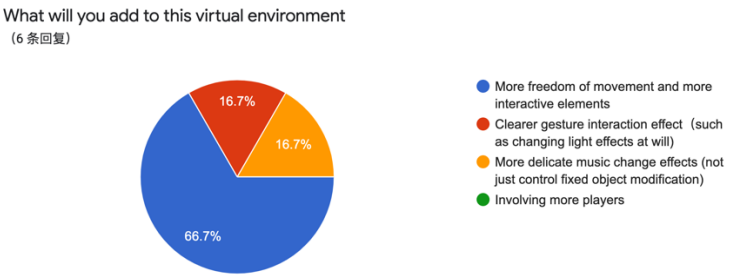

Figure 9: User research result of Miracle (3)

VII. Conclusion

This study summarizes the iterative design process of the immersive VR game Miracle. The report presents the conceptual design considerations for Miracle, focusing on the design strategy and player feedback on Miracle's interaction difficulty and game engagement. The result shows that the first-person perspective VR games need to consider the player movement speed and collision body parameters in different scenarios. The interaction difficulty of the game does not affect the playability to a certain extent, and the interaction settings that match the scene's atmosphere will help enhance the player's participation. In addition, the player's experience length is not better for the exploration class VR game to extend too long. Too long experiencing time is easy to trigger motion sickness. Finally, adjusting the in-game atmosphere by grabbing objects and changing the physical environment and some sound effects has an essential role in the game's mission engagement. In order to constantly provide an attraction for the game players, the balance of consistency and difference for the game's interaction can contribute to this and make the players feel exciting and fresh in the middle and later stages.

List of Illustrations

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